# Test Report
# 23-1-0086302T012a-C3

| | | | |
|---|---|---|---|
| **Number of pages:** | 31 | **Date of Report:** | 2025-Jun-12 |
| **Testing company:** | cetecom advanced GmbH<br>Untertuerkheimer Str. 6-10<br>66117 Saarbruecken<br>GERMANY | **Applicant:** | indurad GmbH |
| **Product:**<br>**Model:** | **2D Scanning Radar**<br>**iSDR-M-G5** | | |
| **FCC ID:** | **2AJRSISDRG5** | | |
| **Testing has been carried out in accordance with:** | **FCC Regulations**<br>**Title 47 CFR, Chapter I, Subchapter D, Part 95**<br>**Subpart M**<br>**The 76-81 GHz Band Radar Service**<br>§ 95.3367 76-81 GHz Band Radar Service radiated power limits<br>§ 95.3379 76-81 GHz Band Radar Service unwanted emissions limits | | |
| **Tested Technology:** | Radar (76G – 81GHz) | | |
| **Test Results:** | **☒ The EUT complies with the requirements in respect of selected parameters subject to the test.**<br>The test results relate only to devices specified in this document | | |

The current version of test report 23-1-0086302T012a-C3 replaces the test report 23-1-0086302T012a-C2, dated 2025-Jun-05. The replaced test report is herewith invalid.

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# 1 General information

## 1.1 Disclaimer and Notes

The test results of this test report relate exclusively to the test item specified in this test report as specified in chapter 2.7. cetecom advanced does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

## 1.2 Summary of Test Results

The EUT integrates a Radar transmitter. Other implemented wireless technologies were not considered within this test report.

| Test specification clause | Test case | Temperature conditions | Power source voltages | Pass | Fail | NA | NP | Remark |
|---|---|---|---|---|---|---|---|---|
| §2.1046<br>§95.3367 (a) / (b) | Radiated power | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | complies |
| §2.1047 | Modulation characteristics | -/- | -/- | ☒ | ☐ | ☐ | ☐ | See Annex 5 |
| §2.1049 | Occupied bandwidth (99% bandwidth) | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | complies |
| §2.1051 | Spurious emissions at antenna terminals | Nominal | Nominal | ☐ | ☐ | ☒ | ☐ | See note 2, DUT has integral antenna |
| §2.1053<br>§95.3379 (a)(1)<br>§95.3379 (a)(2)<br>§95.3379 (a)(3) | Unwanted emissions (radiated spurious) | Nominal | Nominal | ☒ | ☐ | ☐ | ☐ | complies |
| §2.1055<br>§95.3379 (b) | Frequency stability | Nominal and Extreme | Nominal and Extreme | ☒ | ☐ | ☐ | ☐ | complies |

**Note:**

1) C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

2) ANSI C63.26-2015, chapter 5.5.1:
"…many contemporary portable transmitters utilize integral antennas, precluding access to an antenna output port from which to perform conducted compliance measurements. For these types of transmitters, all of the data necessary to demonstrate compliance must be measured in a radiated test configuration…"

## 1.3 Summary of Test Methods

| Test standard | Date | Description |
|---|---|---|
| FCC – Title 47, Chapter I Subchapter D | -- | Part 95, Subpart M, The 76-81GHz Band Radar Service |

| Guidance | Version | Description |
|---|---|---|
| ANSI C63.4-2014 | -/- | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| ANSI C63.26-2015 | -/- | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services |
| ANSI C63.10-2020 | -/- | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| 76-81 GHz Radars KDB | v01r02 | 653005 D01 76-81 GHz Radars v01r02: EQUIPMENT AUTHORIZATION GUIDANCE FOR 76-81 GHz RADAR DEVICES |

# 2 Administrative Data

## 2.1 Identification of the Testing Laboratory

| | |
|---|---|
| Company name: | cetecom advanced GmbH |
| Address: | Untertuerkheimer Str. 6-10<br>66117 Saarbruecken<br>Germany |
| Responsible for testing laboratory: | Dipl.-Ing. (FH) Andreas Luckenbill M.Sc. |
| Accreditation scope: | **DAkkS Webpage: FCC ISED** |
| FCC: | DE0003 |
| Test location 1: | Im Teelbruch 116; 45219 Essen |
| Test location 2: | Untertuerkheimer Str. 6-10; 66117 Saarbruecken |

## 2.2 General limits for environmental conditions

| | |
|---|---|
| Temperature: | 22±2 °C |
| Relative. humidity: | 45±15% rH |

## 2.3 Test Laboratories sub-contracted

| | |
|---|---|
| Company name: | -- |

## 2.4 Organizational Items

| | |
|---|---|
| Responsible test manager: | Al-Amin Hossain |
| Receipt of EUT: | 2023-Dec-12 |
| Date(s) of test: | 2023-Dec-12 to 2024-Mar-26 |
| Version of template: | 24.0101 |

## 2.5 Applicant's details

| | |
|---|---|
| Applicant's name: | indurad GmbH |
| Address: | Belvederealle 5<br>52070 Aachen<br>North Rhine-Westphalia<br>Germany |
| Contact Person: | Matthias Rabel |
| Contact Person's Email: | matthias.rabel@indurad.com |

## 2.6 Manufacturer's details

| | |
|---|---|
| Manufacturer's name: | indurad GmbH |
| Address: | Belvederealle 5<br>52070 Aachen<br>Deutschland |

## 2.7 Equipment under Test (EUT)

| EUT No.*) | Sample No. | Product | Model | Type | SN | HW | SW |
|---|---|---|---|---|---|---|---|
| EUT 1 | 23-1-00863S16_C01 | 2D Scanning Radar | iSDR-M-G5 | iSDR-M-G5- DN 135 | d071a3 | G5 | E5 |
| EUT 2 | 23-1-00863S23_C01 | 2D Scanning Radar | iSDR-M-G5 | iSDR-M-G5- DN 135V | 39746e | G5 | E5 |
| EUT 3 | 23-1-00863S03_C01 | 1D Radar | iLDR-M-G5 | iLDR-M-G5-DN100 | -- | G5 | E5 |

*) EUT short description is used to simplify the identification of the EUT in this test report.

## 2.8 Untested Variant (VAR)

| VAR No.*) | Sample No. | Product | Model | Type | SN | HW | SW |
|---|---|---|---|---|---|---|---|
| -- | -- | 2D Scanning Radar | iSDR-M-G5 | iSDR-M-G5-DN 135**F** | -- | G5 | E5 |
| -- | -- | 2D Scanning Radar | iSDR-M-G5 | iSDR-M-G5-DN 135**VF** | -- | G5 | E5 |

*) The listed additional untested model variant(s) (VAR) is/are not object of evaluation of compliance. For further information please see Annex 5: Declaration of applicant of model differences.
If the table above does not show any other line than the headline, no untested variants are available.

## 2.9 Auxiliary Equipment (AE)

| AE No.*) | Sample No. | Auxiliary Equipment | Model | SN | HW | SW |
|---|---|---|---|---|---|---|
| AE 1 | 23-1-00863S17_C01 | Laptop | Thinkpad | PF-4QBH1Y | -- | -- |
| AE 2 | 23-1-00863S18_C01 | Laptop charger/Adapter | -- | -- | -- | -- |
| AE 3 | 23-1-00863S19_C01 | Ethernet Adapter | A7613 | -- | -- | -- |
| AE 4 | 23-1-00863S09_C01 | Laptop | ThinkPad | heineken 77-81GHz | - | run iDat solution |

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report. If the table above does not show any other line than the headline, no AE was used during testing nor was taken into account for evaluation

## 2.10 Connected cables (CAB)

| CAB No.*) | Sample No. | Cable Type | Connectors / Details | Length |
|---|---|---|---|---|
| CAB 1 | 23-1-00863S20_C01 | Harness | -- | N/A |
| CAB 2 | -- | LAN | RJ45 | N/A |
| CAB 3 | 23-1-00863S06_C01 | Cable harness | -- | N/A |

*) CAB short description is used to simplify the identification of the connected cables in this test report. If the table above does not show any other line than the headline, no cable was used during testing nor was taken into account for evaluation

## 2.11 Software (SW)

| SW No.*) | Sample No. | SW Name | Description | SW Status |
|---|---|---|---|---|

*) SW short description is used to simplify the identification of the used software in this test report. If the table above does not show any other line than the headline, no SW was used during testing nor was taken into account for evaluation.

## 2.12 EUT set-ups

| set-up no.*) | Combination of EUT and AE | Description |
|---|---|---|
| Set 1 | EUT 1+ AE 1 + AE 2 + AE 3 + CAB 1 + CAB 2 | This setup has been used for radiated measurements |
| Set 2 | EUT 2+ AE 1 + AE 2 + AE 3 + CAB 1 + CAB 2 | This setup has been used for radiated measurements |
| Set 3 | EUT 3+ AE 4 + CAB 2 + CAB 3 | This setup has been used for frequency stability measurements with extreme temperature voltage condition |

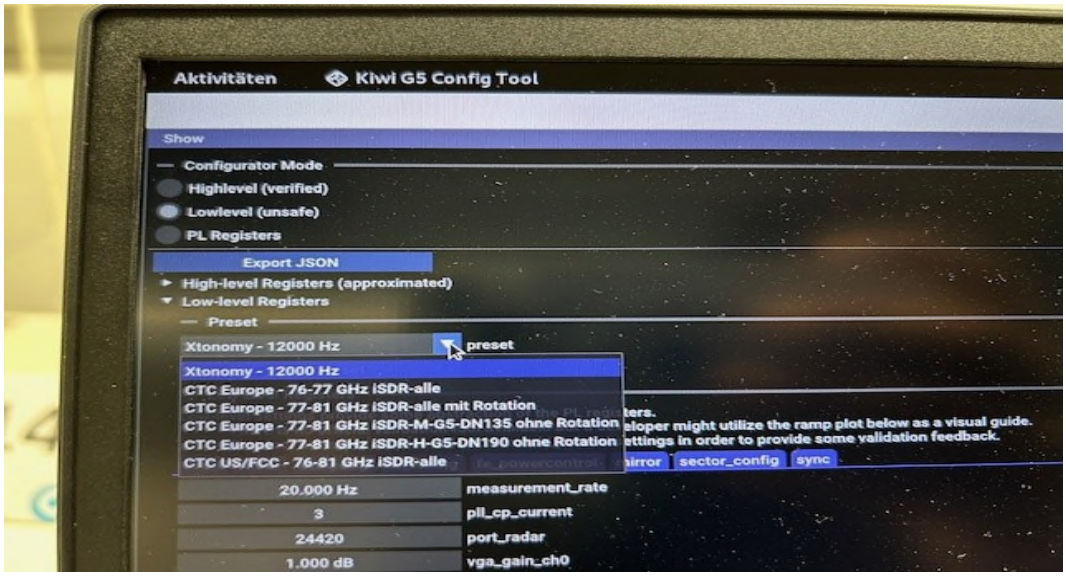
*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

## 2.13 EUT operation modes

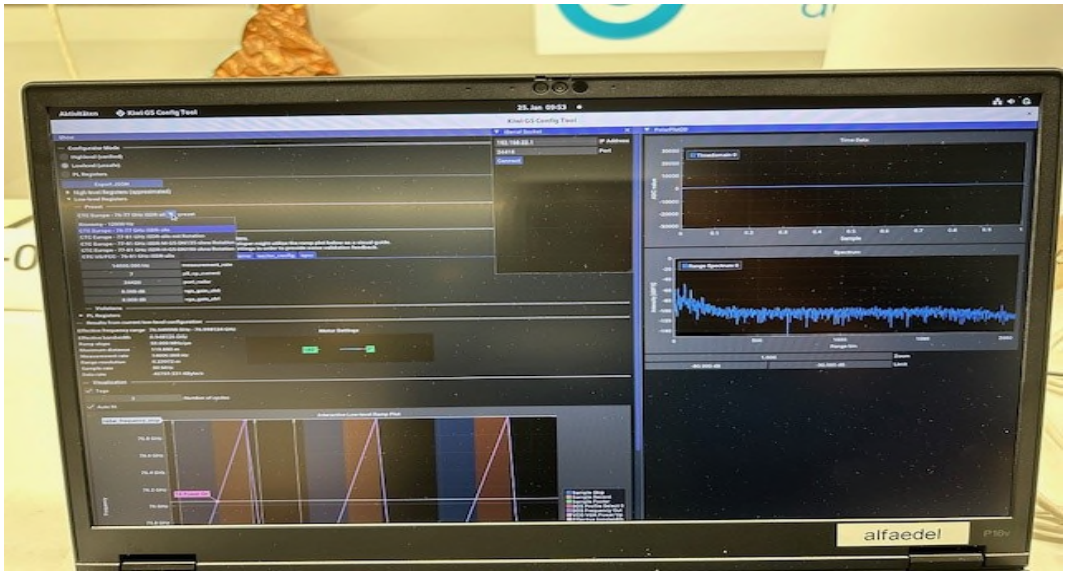
| EUT operating mode no.*) | Operating modes | Additional information |
|---|---|---|
| op. 1 | Normal TXRX ,mode<br><br>EUT set to Normal mode (76G – 81GHz) | ➢ AE 1 + AE 3 + CAB 2 have been used to set the EUT in operation mode<br>➢ Customer Provided Tool has been used to set the EUT in operation.<br>➢ For more information regarding Test tool, check below chapter 2.14<br>➢ EUT Antenna without Rotation |

*) EUT operating mode no. is used to simplify the test report.

## 2.14 Test tool information




Note: EUT operating mode set to in different frequency / different mode by the help of customer provided tool.
In this case EUT set to 76 – 81GHz frequency mode.




Note: Customer provided tool to verify RADAR is active and working properly.

# 3 Equipment under test (EUT)

## 3.1 General Data of Main EUT as Declared by Applicant

| | | | |
|---|---|---|---|
| **Firmware** | ☐ normal use | ☒ Special version for test execution | |
| **Power supply** | ☐ AC Mains | -- | |
| | ☒ DC Mains | 24V DC | |
| | ☐ Battery | | |
| **Operational conditions** | $T_{nom}$ =22 °C | -- | -- |
| **EUT sample type** | **Pre-Production** | | |
| **Weight** | 3.100 kg | | |
| **Size [LxWxH]** | 14.5 cm x 14.5 cm x 20 cm | | |
| **Interfaces/Ports** | Check Annex-3 | | |
| **For further details refer Applicants Declaration & following technical documents** | | | |

## 3.2 Detailed Technical data of Main EUT as Declared by Applicant

| | | | |
|---|---|---|---|
| **TX Frequency range [MHz]** | 76 GHz to 81 GHz | | |
| **Type of modulation used** | FMCW | | |
| **Antenna polarization** | Vertical (Worst case) | | |
| **Modulation method** | F3N (FMCW) | | |
| **Bandwidth** | <4000 MHz | | |
| **Coaxial antenna connector available** | ☒ No connector | ☐ Only for testing purpose | ☐ Regular use |
| **Antenna Type** | ☐ Integrated – monopole<br>☒ External, no RF- connector<br>☐ External, separate RF-connector | | |
| **Antenna Gain (DN135)**<br>**Antenna Gain (DN135V)** | 33 dBi<br>28 dBi | ☒ Declared by applicant | ☐ Measured |
| **For further details refer Applicants Declaration & following technical documents** | | | |

| Description of Reference Document (supplied by applicant) | Version | Total Pages |
|---|---|---|
| **2023-11-08_iSDR-M_antenna_description_V1** | **V1** | **9** |

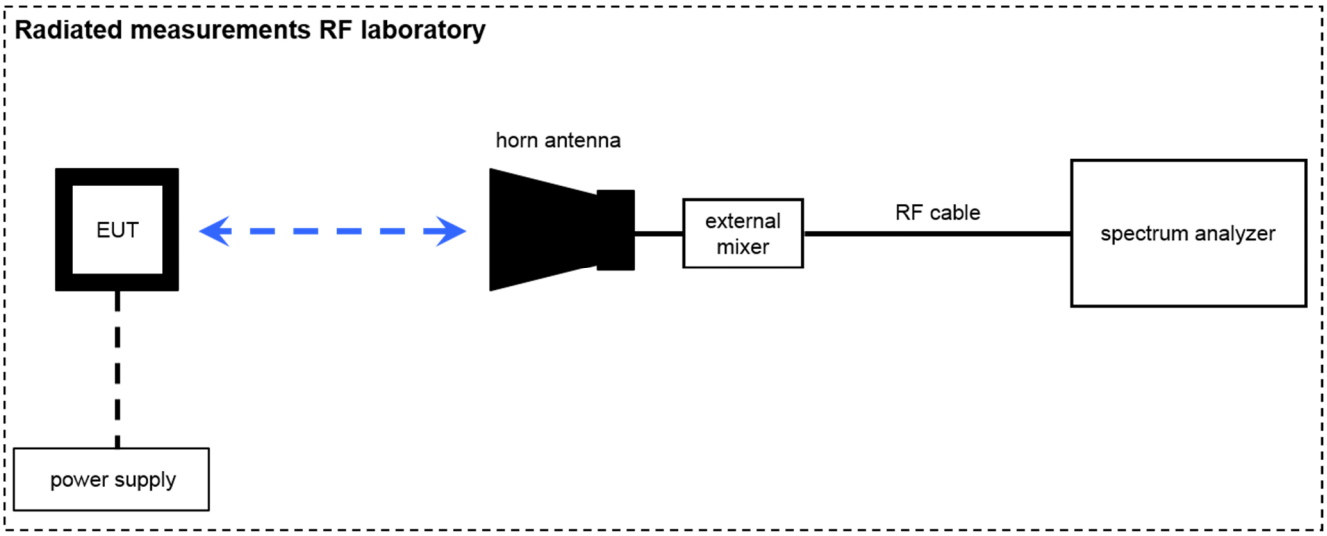
## 3.3 Modifications on Test sample

| | |
|---|---|
| Additions/deviations or exclusions | -- |

# 4 Measurements

## 4.1 The maximum peak power EIRP / peak EIRP spectral density. The maximum power EIRP/ average EIRP.

Schematic:




OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance;
G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -65.0 [dBm] + 50.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)
Note: conversion loss of mixer is already included in analyzer value.

Testing method:
All the measurements are done according to standards and rules listed in subsection 5.1.2. The measured power is EIRP*.
The EUT is ON and set to default mode: FMCW modulation. EUT is tested under nominal condition.
For the maximum peak power EIRP / peak EIRP spectral density test function Signal-ID is activated to exclude ghost signals (product of the mixer).
*EIRP: Equivalent Isotropic Radiated Power

### 4.1.1 Measurement Location

| | |
|---|---|
| **Test site** | 120907 - FAC2 - Radiated Emissions |

## Description:

§95.3367:
The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as shown below.

## Limits:

**FCC §95.3367 (a) (b)**

| Frequency | Limit (eirp) |
|---|---|
| 76.0 - 81.0 GHz | 50 dBm (Average) |
| 76.0 - 81.0 GHz | 55 dBm/MHz (PEAK) |

## Measurement: Average Power

| Measurement parameter | |
|---|---|
| Detector: | RMS |
| Resolution bandwidth: | 1 MHz |
| Video bandwidth: | 3 MHz |
| Trace-Mode: | Max Hold |

## Measurement: Peak Power

| Measurement parameter | |
|---|---|
| Detector: | Pos-Peak |
| Resolution bandwidth: | 50 MHz |
| Video bandwidth: | 80 MHz |
| Trace-Mode: | Max Hold |

**Note: KDB 653005 4.(c)(1)**
Peak power measurements of swept frequency radar implementations (e.g., high sweep rate FMCW) may require a desensitization correction factor to be applied to the measurement results.

**Consequence:**
Worst case measurement, the peak power measurement is performed with a greater resolution bandwidth to solve the problem with the desensitization.

## 4.1.2 Result

| Diagram | EUT Setup | Peak detector, max peak search (marker) [dBm] | Peak detector, max peak search (marker frequency) [GHz] | RMS detector, channel power measurement [dBm] | Voltage [V] | Temperature [°C] | Result |
|---|---|---|---|---|---|---|---|
| D107 | 1 | 37.34 | 76.067 | -- | 24 DC | 22 | Passed |
| D112 | 1 | -- | -- | 32.55 | 24 DC | 22 | Passed |
| D605 | 2 | 32.08 | 76.549 | -- | 24 DC | 22 | Passed |
| D612 | 2 | -- | -- | 27.63 | 24 DC | 22 | Passed |

Note-1: for more information and graphical plot see annex A1 **TR23-1-0086302T012a-A1**

Note-2: EUT setup-1 has more Antenna gain than EUT setup-2

Note-3: Maximum Radiated Power has been found with EUT setup-1, therefore all radiated spurious emission measurements are performed with EUT setup-1 as worst case scenario.

## 4.2 Modulation characteristics

**Description:**

§2.1047 (d) *Other types of equipment.* A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

KDB 653005 D01 76-81 GHz Radars v01r02, section 3 (g)
Concerning the Section 2.1047 modulation characteristics requirement, the following information should be provided:
1) Pulsed radar: pulse width and pulse repetition frequency (if PRF is variable, then report maximum and minimum values).
2) Non-pulsed radar (e.g., FMCW): modulation type (i.e., sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).

For this measurement, please check customer provided document in Annex 5.

## 4.3 Occupied bandwidth

**Description:**
§2.1049 The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

**Limits:**

| FCC |
|---|
| FCC §95.3379 (b) |
| The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following: |
| Frequency range |
| 76 GHz – 81 GHz |

**Measurement:**

| Parameters | |
|---|---|
| Detector: | Pos-Peak |
| Resolution bandwidth: | 50 MHz |
| Video bandwidth: | 80 MHz |
| Trace-Mode: | Max Hold |

### 4.3.1 Result

| Diagram | EUT setup | Low edge [GHz] | High edge [GHz] | Voltage [V] | Temperature [°C] | Occ. bandwidth [GHz] | Result |
|---|---|---|---|---|---|---|---|
| D110 | 1 | 76.0634 | 80.9305 | 24 | 22 | 4.88 | Passed |
| D609 | 2 | 76.0865 | 80.9253 | 24 | 22 | 4.84 | Passed |

Remark: for more information and graphical plot see annex A1 **TR23-1-0086302T012a-A1**

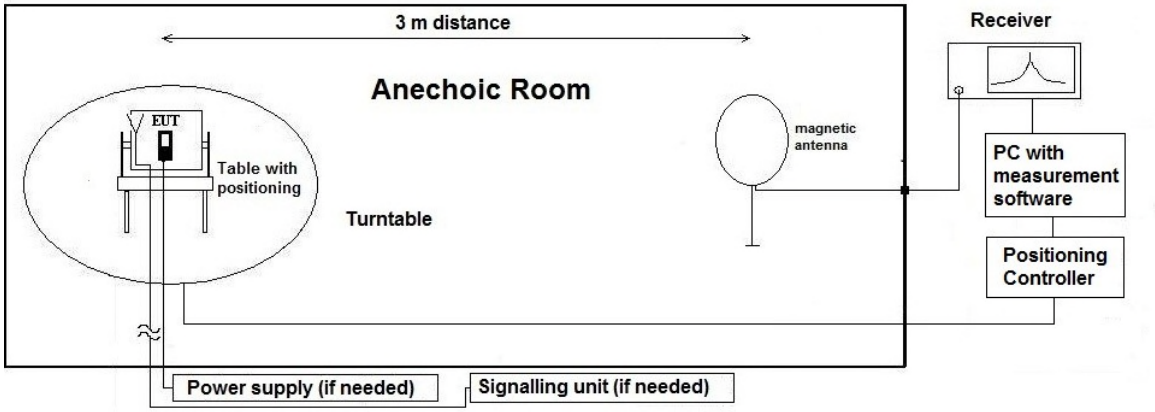
## 4.4 Radiated field strength emissions below 30 MHz

### 4.4.1 Description of the general test setup and methodology, see below example:

Evaluating the radiated field emissions are done first by an exploratory emission measurement and a final measurement for most critical frequencies determined.

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in chapter "General Limit - Radiated field strength emissions below 30 MHz". The tests are performed in the semi anechoic room recognized by the regulatory commission.

### Schematic:




### Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5)

**Exploratory, preliminary measurements**
The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0°to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum was recorded.

The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

**Final measurement on critical frequencies**
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position).

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

### Formula:

$E_C = E_R + AF + C_L + D_F - G_A$

$M = L_T - E_C$

AF = Antenna factor
$C_L$ = Cable loss
$D_F$ = Distance correction factor (if used)
$E_C$ = Electrical field – corrected value
$E_R$ = Receiver reading
$G_A$ = Gain of pre-amplifier (if used)
$L_T$ = Limit
M = Margin

All units are dB-units, positive margin means value is below limit.

## 4.4.2 Sample calculation

| Raw-Value [dBuV/m] | Antenna factor | Distance Correction [dB] | Cable Loss | Preamplifier | Resulting correction value [dB] | Final result [dBuV/m] | Remarks |
|---|---|---|---|---|---|---|---|
| 19.83 | 18.9 | -70.75 | 0.18 | -- | -51.67 | -31.83 | 30 to 3 m correction used according ANSI C63.10-2020 |

Remark: This calculation is based on an example value at 458 kHz

### 4.4.3 Correction factors due to reduced meas. distance (f < 30 MHz):

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of 0.625xLambda. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors

| Frequency Range | f [kHz/MHz] | Lambda [m] | Far-Field Point [m] | Distance Limit accord. 15.209 [m] | 1st Condition (dmeas < Dnear-field) | 2nd Condition (Limit distance bigger dnear-field) | Distance Correction accord. Formula |
|---|---|---|---|---|---|---|---|
| kHz | 9 | 33333.33 | 5305.17 | 300 | fullfilled | not fullfilled | -80.00 |
| | 10 | 30000.00 | 4774.65 | | fullfilled | not fullfilled | -80.00 |
| | 20 | 15000.00 | 2387.33 | | fullfilled | not fullfilled | -80.00 |
| | 30 | 10000.00 | 1591.55 | | fullfilled | not fullfilled | -80.00 |
| | 40 | 7500.00 | 1193.66 | | fullfilled | not fullfilled | -80.00 |
| | 50 | 6000.00 | 954.93 | | fullfilled | not fullfilled | -80.00 |
| | 60 | 5000.00 | 795.78 | | fullfilled | not fullfilled | -80.00 |
| | 70 | 4285.71 | 682.09 | | fullfilled | not fullfilled | -80.00 |
| | 80 | 3750.00 | 596.83 | | fullfilled | not fullfilled | -80.00 |
| | 90 | 3333.33 | 530.52 | | fullfilled | not fullfilled | -80.00 |
| | 100 | 3000.00 | 477.47 | | fullfilled | not fullfilled | -80.00 |
| | **125** | 2400.00 | 381.97 | | fullfilled | not fullfilled | -80.00 |
| | 200 | 1500.00 | 238.73 | | fullfilled | fullfilled | -78.02 |
| | 300 | 1000.00 | 159.16 | | fullfilled | fullfilled | -74.49 |
| | 400 | 750.00 | 119.37 | | fullfilled | fullfilled | -72.00 |
| | **490** | 612.24 | 97.44 | | fullfilled | fullfilled | -70.23 |
| | 500 | 600.00 | 95.49 | 30 | fullfilled | not fullfilled | -40.00 |
| | 600 | 500.00 | 79.58 | | fullfilled | not fullfilled | -40.00 |
| | 700 | 428.57 | 68.21 | | fullfilled | not fullfilled | -40.00 |
| | 800 | 375.00 | 59.68 | | fullfilled | not fullfilled | -40.00 |
| | 900 | 333.33 | 53.05 | | fullfilled | not fullfilled | -40.00 |
| MHz | 1.00 | 300.00 | 47.75 | | fullfilled | not fullfilled | -40.00 |
| | **1.59** | 188.50 | **30.00** | | fullfilled | not fullfilled | -40.00 |
| | 2.00 | 150.00 | 23.87 | | fullfilled | fullfilled | -38.02 |
| | 3.00 | 100.00 | 15.92 | | fullfilled | fullfilled | -34.49 |
| | 4.00 | 75.00 | 11.94 | | fullfilled | fullfilled | -32.00 |
| | 5.00 | 60.00 | 9.55 | | fullfilled | fullfilled | -30.06 |
| | 6.00 | 50.00 | 7.96 | | fullfilled | fullfilled | -28.47 |
| | 7.00 | 42.86 | 6.82 | | fullfilled | fullfilled | -27.13 |
| | 8.00 | 37.50 | 5.97 | | fullfilled | fullfilled | -25.97 |
| | 9.00 | 33.33 | 5.31 | | fullfilled | fullfilled | -24.95 |
| | 10.00 | 30.00 | 4.77 | | fullfilled | fullfilled | -24.04 |
| | 10.60 | 28.30 | 4.50 | | fullfilled | fullfilled | -23.53 |
| | 11.00 | 27.27 | 4.34 | | fullfilled | fullfilled | -23.21 |
| | 12.00 | 25.00 | 3.98 | | fullfilled | fullfilled | -22.45 |
| | **13.56** | 22.12 | 3.52 | | fullfilled | fullfilled | -21.39 |
| | 15.00 | 20.00 | 3.18 | | fullfilled | fullfilled | -20.51 |
| | 15.92 | 18.85 | **3.00** | | fullfilled | fullfilled | -20.00 |
| | 17.00 | 17.65 | 2.81 | | not fullfilled | fullfilled | -20.00 |
| | 18.00 | 16.67 | 2.65 | | not fullfilled | fullfilled | -20.00 |
| | 20.00 | 15.00 | 2.39 | | not fullfilled | fullfilled | -20.00 |
| | 21.00 | 14.29 | 2.27 | | not fullfilled | fullfilled | -20.00 |
| | 23.00 | 13.04 | 2.08 | | not fullfilled | fullfilled | -20.00 |
| | 25.00 | 12.00 | 1.91 | | not fullfilled | fullfilled | -20.00 |
| | 27.00 | 11.11 | 1.77 | | not fullfilled | fullfilled | -20.00 |
| | 29.00 | 10.34 | 1.65 | | not fullfilled | fullfilled | -20.00 |
| | 30.00 | 10.00 | 1.59 | | not fullfilled | fullfilled | -20.00 |

### 4.4.4 Measurement Location

| Test site | SAC 3 |
|---|---|

### 4.4.5 Limit

| Radiated emissions limits (3 meters) | | | | | |
|---|---|---|---|---|---|
| Frequency Range [MHz] | Limit [µV/m] | Limit [dBµV/m] | Distance [m] | Detector | RBW [kHz] |
| 0.009 – 0.09 | 2400 / f [kHz] | 67.6 – 20Log(f) (kHz) | 300 | Pk & Avg | 0.2 |
| 0.09 – 0.11 | 2400 / f [kHz] | 67.6 – 20Log(f) (kHz) | 300 | Quasi peak | 0.2 |
| 0.11 – 0.15 | 2400 / f [kHz] | 67.6 – 20Log(f) (kHz) | 300 | Pk & Avg | 0.2 |
| 0.15 – 0.49 | 2400 / f [kHz] | 67.6 – 20Log(f) (kHz) | 300 | Pk & Avg | 9 |
| 0.49 – 1.705 | 24000 / f [kHz] | 87.6 – 20Log(f) (kHz) | 30 | Quasi peak | 9 |
| 1.705 - 30 | 30 | 29.5 | 30 | Quasi peak | 9 |

*Remark: In Canada same limits apply, just unit reference is different

### 4.4.6 Result

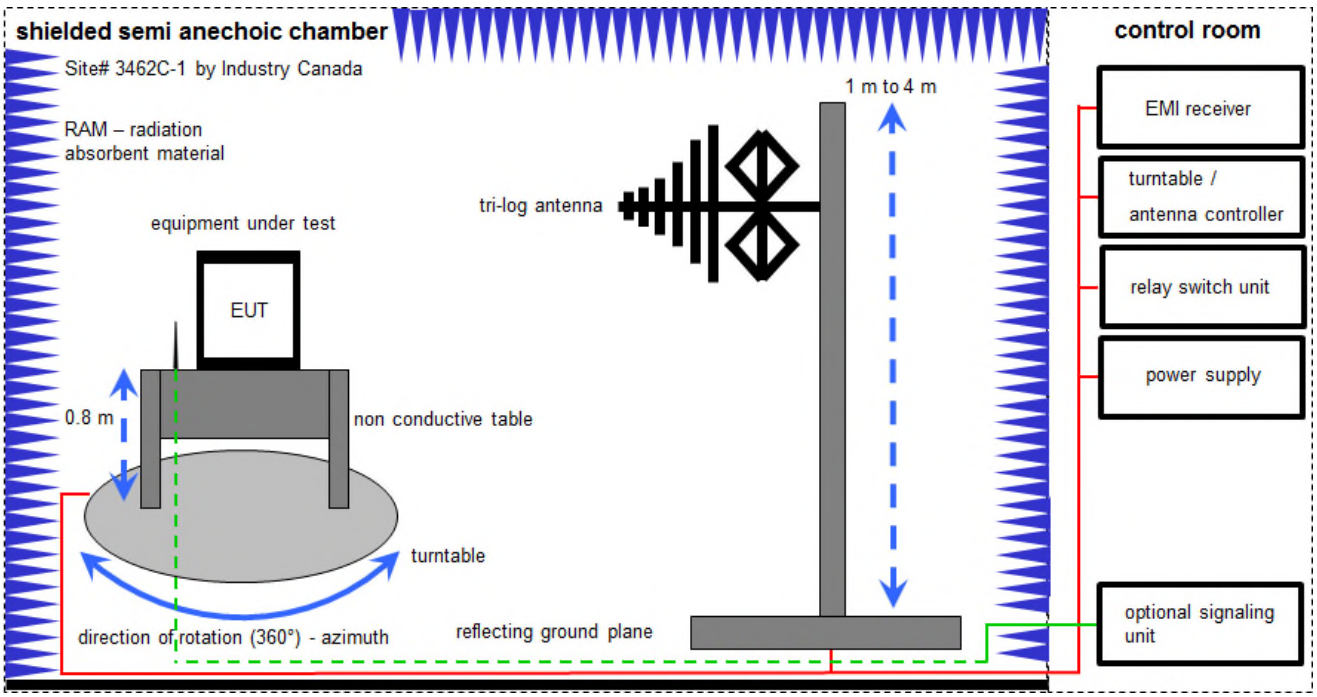
| Diagram | Setup | Mode | Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz | Result |
|---|---|---|---|---|
| D113 | 1 | 1 | No critical emission found | Passed |

Remark: for more information and graphical plot see annex A1 **TR23-1-0086302T012a-A1**

## 4.5 Radiated field strength emissions 30 MHz – 1000 MHz

### 4.5.1 Description of the general test setup and methodology, see below example:

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.




Measurement distance: tri-log antenna 10 meter

FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

*Example calculation:*
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

### 4.5.2 Measurement Location

| Test site | Halle F, SB |
|---|---|

### 4.5.3 Limit

| Radiated emissions limits (3 meters) | | | | |
|---|---|---|---|---|
| Frequency Range [MHz] | Limit [µV/m] | Limit [dBµV/m] | Detector | RBW / VBW [kHz] |
| 30 - 88 | 100 | 40.0 | Quasi peak | 100 / 300 |
| 88 - 216 | 150 | 43.5 | Quasi peak | 100 / 300 |
| 216 - 960 | 200 | 46.0 | Quasi peak | 100 / 300 |
| 960 - 1000 | 500 | 54.0 | Quasi peak | 100 / 300 |

### 4.5.4 Result

| Diagram | EUT Setup | Operation Mode | Maximum Level [dBµV/m] Frequency Range 30M – 1000 MHz | Result |
|---|---|---|---|---|
| 6513_01_04_L_DC | 1 | 1 | 33.67dBµV/m@249.966MHz | Passed |

Remark: for more information and graphical plot see annex A1 **TR23-1-0086302T012a-A1**

## Equipment table (Chamber F):

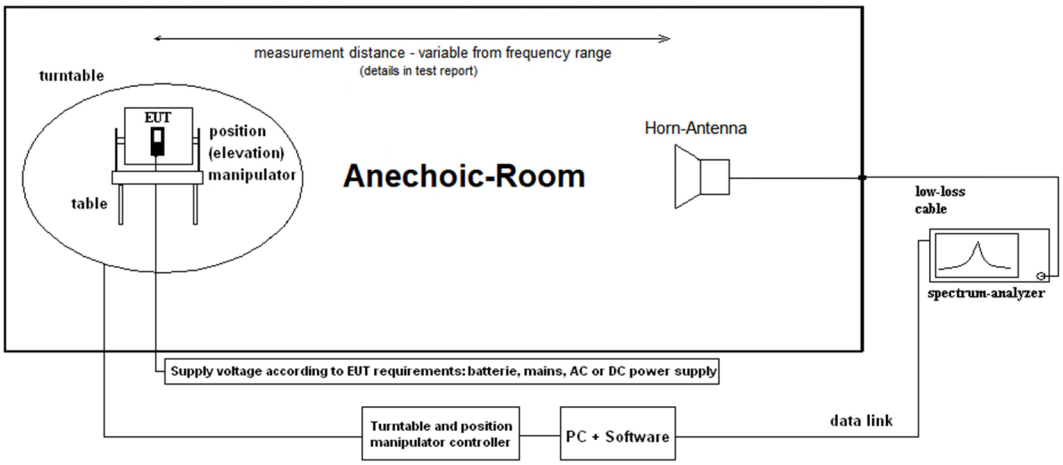
| No. | Lab / Item | Equipment | Type | Manufacturer | Serial No. | INV. No. | Kind of Calibration | Last Calibration | Next Calibration |
|---|---|---|---|---|---|---|---|---|---|
| 1 | n. a. | Switch-Unit | 3488A | HP | 2719A14505 | 300000368 | ev | -/- | -/- |
| 2 | n. a. | DC power supply, 60Vdc, 50A, 1200 W | 6032A | HP | 2920A04466 | 300000580 | ne | -/- | -/- |
| 3 | n. a. | Semi anechoic chamber | 300023 | MWB AG | -/- | 300000551 | ne | -/- | -/- |
| 4 | n. a. | Antenna Tower | Model 2175 | ETS-Lindgren | 64762 | 300003745 | izw | -/- | -/- |
| 5 | n. a. | Positioning Controller | Model 2090 | ETS-Lindgren | 64672 | 300003746 | izw | -/- | -/- |
| 6 | n. a. | Turntable Interface-Box | Model 105637 | ETS-Lindgren | 44583 | 300003747 | izw | -/- | -/- |
| 7 | n. a. | EMI Test Receiver | ESR3 | Rohde & Schwarz | 102587 | 300005771 | k | 09.12.2022<br>06.12.2023 | 31.12.2023<br>31.12.2024 |
| 8 | n. a. | PC | TecLine | F+W | -/- | 300004388 | ne | -/- | -/- |
| 9 | n. a. | TRILOG Broadband Test-Antenna 30 MHz - 3 GHz | VULB9163 | Schwarzbeck Mess - Elektronik | 295 | 300003787 | vlKl! | 12.04.2021<br>23.05.2023 | 30.04.2023<br>31.05.2025 |

## 4.6 Radiated field strength emissions 1 GHz – 50 GHz

### 4.6.1 Description of the general test setup and methodology, see below example:

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 18-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. Horn antennas are used for frequency range 1 GHz to 50 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with worst case position on the EUT.

### Schematic:




### Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5)

**Exploratory, preliminary measurements**
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 15°) and the EUT itself worst case position, the emission spectrum and it's characteristics was recorded with an EMI-receiver and software.
The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

**Final measurement on critical frequencies**
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself worst case position and the height for EUT with large dimensions.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

### Formula:

$P_{EIRP} = P_{MEAS} + C_L + FSL - G_A$ (1)

$P_{MEAS}$ = measured power at instrument
M = Margin
$L_T$ = Limit

FSL = Free Space loss = Function(frequency, measurement distance)

$M = L_T - P_{EIRP}$

$C_L$= cable loss
$G_A$ = Gain of pre-amplifier (if used)

All units are dB-units, positive margin means value is below limit.

## 4.6.2 Sample calculation

| Raw-Value [dBuV/m] | Antenna factor | Distance Correction [dB] | Cable Loss + Preamplifier | Resulting correction value [dB] | Final result [dBuV/m] | Remarks |
|---|---|---|---|---|---|---|
| 29.37 | 41.20 | -- | 24.28 | 16.92 | 46.3 | CableLoss and PreAmp data in one data correction file |

Remark: This calculation is based on an example value at 10 GHz

## 4.6.3 Measurement Location

| Test site | 120907 - FAC2 - Radiated Emissions |
|---|---|

## 4.6.4 Limit

| Frequency Range [MHz] | EIRP [dBm] | Field strength [dBµV/m] | RBW / VBW [kHz] |
|---|---|---|---|
| 1000 – 40000 | -21.23/ −41.23 | 74 (PK) / 54 (AV) | 1000 / 3000 |
| 40000 – 50000 | -1.7 | -- | 1000 / 3000 |

EIRP limit was calculated according to the equation (38) in ANSI C63.10-2020:
EIRP[dBm] = E[dBµV/m]+ 20log(d [m])−104.77
EIRPlimit = [54 + 20log(3)−104.77] dBm
= [54 + 9.54−104.77] dBm
= -41.23 dBm

## 4.6.5 Measurement distance

| Frequency Range [GHz] | Measurement distance [m] |
|---|---|
| 1 – 15 | 3 |
| 15 – 18 | 2 |
| 18 – 40 | 1 |
| 40 – 50 | 2 |

### 4.6.6 Result

| Diagram | Mode | EUT Setup | Frequency [GHz] | Max level [dBm] | Result |
|---|---|---|---|---|---|
| D115 | 1 | 1 | 1 – 15 | No critical emission found | Passed |
| D116 | 1 | 1 | 15 – 18 | No critical emission found | Passed |
| D117 | 1 | 1 | 18 – 40 | No critical emission found | Passed |
| D118 | 1 | 1, Ant Ver | 40G – 50GHz | No critical frequency found | Passed |
| D118_01 | 1 | 1, Ant Hor | 40G – 50GHz | No critical frequency found | Passed |

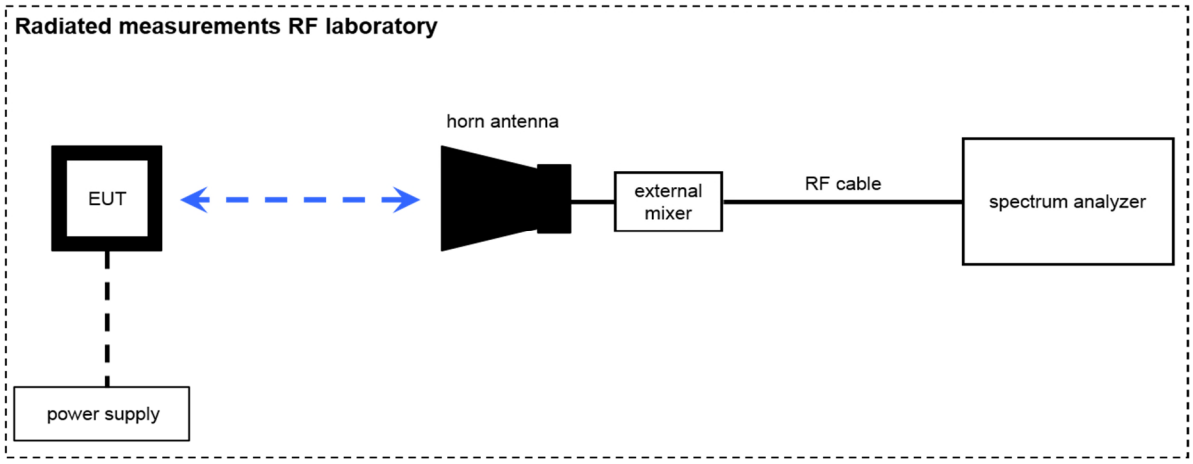
Remark:

- for more information and graphical plot see annex A1 **TR23-1-0086302T012a-A1**
- Only worst case Antenna polarization measurement's results are stated here.

## 4.7 Radiated field strength emissions, above 50 GHz

### 4.7.1 Description of the general test setup and methodology, see below example:

Schematic:




OP = AV + D - G + CA

(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:

OP [dBm] = -65.0 [dBm] + 50.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

Note: conversion loss of mixer is already included in analyzer value.

Testing method:

All the measurements are done according to standards and rules listed in subsection 5.1.2. The measured power is EIRP*.

The EUT is ON and set to default mode: FMCW modulation. EUT is tested under nominal condition.

For the maximum peak power EIRP / peak EIRP spectral density test function Signal-ID is activated to exclude ghost signals (product of the mixer).

*EIRP: Equivalent Isotropic Radiated Power

### Calculation of the boundary near/far field:

The aperture dimensions of the antenna shall be small enough so that the measurement distance in m is equal to or greater than the Rayleigh (far-field) distance (i.e., Rm = 2D2 / λ), where D is the largest dimension of the antenna aperture in m and λ is the free-space wavelength in m at the frequency of measurement.

| Antenna range, [GHz] | D [m] | Highest frequency in the measurement, [GHz] | Lowest wavelength λ in the measurement, [m] | Boundary for near/far field, [m] |
|---|---|---|---|---|
| 50-75 | 0.03072 | 73.5 | 0.004078810 | 0.46 |
| 55-75 | 0.03072 | 74.5 | 0.004024060 | 0.47 |
| 55-75 | 0.03072 | 75 | 0.003997233 | 0.47 |
| 75-110 | 0.020757 | 76 | 0.003944640 | 0.22 |
| 75-110 | 0.020757 | 78.5 | 0.003819010 | 0.23 |
| 75-110 | 0.020757 | 79.5 | 0.003770974 | 0.23 |
| 75-110 | 0.020757 | 81 | 0.003701141 | 0.23 |
| 75-110 | 0.020757 | 90 | 0.003331027 | 0.26 |
| 75-110 | 0.020757 | 98 | 0.003059107 | 0.28 |
| 75-110 | 0.020757 | 110 | 0.002725386 | 0.32 |
| 90-140 | 0.016696 | 122 | 0.002457315 | 0.23 |
| 90-140 | 0.016696 | 130 | 0.002306100 | 0.24 |
| 140-220 | 0.010700 | 220 | 0.001362693 | 0.17 |
| 220-325 | 0.007050 | 250 | 0.001199170 | 0.08 |

**Measurement distance:**

| Measurement frequency range: | Measurement distance [m] | Boundary for near/far field [m] |
|---|---|---|
| 50 GHz – 75 GHz | 1 | 0.47 |
| 75 GHz – 90 GHz | 1 | 0.26 |
| 90GHz – 110 GHz | 0.25 | 0.32 |
| 110 GHz – 140 GHz | 0.5 | 0.25 |
| 140 GHz – 170 GHz | 0.25 | 0.17 |
| 140 GHz – 200 GHz | 0.25 | 0.17 |
| 200 GHz – 220 GHz | 0.25 | 0.08 |
| 220 GHz – 250 GHz | 0.25 | 0.08 |

### 4.7.2 Measurement Location

| Test site | 120907 - FAC2 - Radiated Emissions |
|---|---|

### 4.7.3 Limit

**FCC §95.3379**

(a) The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

| FCC | | |
|---|---|---|
| CFR Part 95.3379 (a) (1) / CFR Part 95.3379 (a) (3) | | |
| Radiated unwanted emissions | | |
| **Frequency (MHz)** | **Field Strength (µV/m)** | **Measurement distance (m)** |
| 0.009 – 0.490 | 2400/F[kHz] | 300 |
| 0.490 – 1.705 | 24000/F[kHz] | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30  88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| 960 – 40 000 | 500 | 3 |

(i) In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.

(ii) The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.

| Frequency Range (GHz) | Power Density | EIRP |
|---|---|---|
| 40 – 200 | 600 pW/cm$^2$ @ 3m | -1.7 dBm |
| 200 – 243 | 1000 pW/cm$^2$ @ 3m | +0.5 dBm |

(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

**Limit conversion (ANSI C63.10-2013 9.6):**

EIRP[dBm] = 10 × log(4 × π × d² × PD[W/m²])

- Power density at the distance specified by the limit: PD [W/m²]
- Equivalent isotropically radiated power: EIRP [dBm]
- Distance at which the power density limit is specified: d [m]

According to this formula, an emission limit of PD = 600 pW/cm² at a distance of d = 3 m corresponds to an equivalent isotropically radiated power of EIRP = -1.7 dBm.

### 4.7.4 Spectrum-Analyzer Settings

| | |
|---|---|
| **Resolution Bandwidth (RBW)** | 1 MHz |
| **Video Bandwidth (VBW)** | Minimum 3 times the resolution bandwidth |
| **Detector** | RMS detector. |
| **Trace-Mode:** | Maxhold |
| **Sweep time** | ≥(Span/RBW)*EUT Cycle Time |

### 4.7.5 Result

| Diagram | EUT Setup | Operation Mode | Frequency Range | Maximum Level [dBm] Frequency Range 40G – 231 GHz | Result |
|---|---|---|---|---|---|
| D119 | 1 | 1 | 50G – 75GHz | No critical frequency found | Passed |
| D120 | 1 | 1 | 75G – 90GHz<br>76G – 81GHz | No critical frequency found, **Note-2** | Passed |
| D121_01 | 1 | 1 | 90G – 110GHz | No critical frequency found | Passed |
| D121_02 | 1 | 1 | 110G – 140GHz | No critical frequency found | Passed |
| D122 | 1 | 1 | 140G – 220GHz | No critical frequency found | Passed |
| D123 | 1 | 1 | 220G – 250GHz | No critical frequency found | Passed |

Note-1: for more information and graphical plot see annex A1 **TR23-1-0086302T012a-A1**
Note-2: 76G – 81GHz, In Band Measurements, check chapter 4.1, 4.3
Note-3: Only worst measurement Antenna polarization noted in this table, for more information check EUT setup picture.

## 4.8 Frequency stability

**Description:**

§95.3379 (b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

**Limits:**

| FCC |
|---|
| FCC §95.3379 (b) |
| The occupied bandwidth from intentional radiators operated within the specified frequency band shall comply with the following: |
| Frequency range |
| 76 GHz – 81 GHz |

**Measurement:**

| Parameters | |
|---|---|
| Detector: | Pos-Peak |
| Resolution bandwidth: | 10 MHz |
| Video bandwidth: | 28 MHz |
| Trace-Mode: | Max Hold |

**Measurement results 99% Occupied Bandwidth:**

| Test condition | Frequency $f_L$ [MHz] | Frequency $f_H$ [MHz] | Bandwidth [MHz] |
|---|---|---|---|
| -20 °C / $V_{nom}$ | 76044.25 | 80906.91 | 4862.6 |
| -10 °C / $V_{nom}$ | 76045.90 | 80904.89 | 4858.9 |
| 0 °C / $V_{nom}$ | 76047.94 | 80910.75 | 4862.8 |
| 10 °C / $V_{nom}$ | 76049.03 | 80914.84 | 4865.8 |
| 20 °C / $V_{nom}$ | See chapter 4.3 results | | |
| 20 °C / $V_{min}$ | 76050.86 | 80917.07 | 4866.2 |
| 20 °C / $V_{max}$ | 76051.06 | 80917.26 | 4866.1 |
| 30 °C / $V_{nom}$ | 76049.01 | 80908.46 | 4859.4 |
| 40 °C / $V_{nom}$ | 76050.22 | 80909.85 | 4859.6 |
| 50 °C / $V_{nom}$ | 76050.27 | 80914.91 | 4864.6 |

**Note:**

- The EUT is measured in the temperature range from -20°C to 50°C specified by §95.3379 (b).
- Since the RF part of iLDR and iSDR are identical, therefore frequency stabilty measurements with extreme condition have been performed only with iLDR variant.

**Result: Passed**

## 4.9 Equipment lists

| ID | Description | Manufacturer | SerNo | CheckType | Last Check | Interval | Next Check |
|---|---|---|---|---|---|---|---|
| | 120901 - SAC3 - Radiated Emission <1GHz | | | calchk | cal: 2015-Jul-21<br>chk: 2021-Jul-27 | cal: 10Y<br>chk: 12M | cal: 2025-Jul-21<br>chk: 2022-Jul-27 |
| 20341 | Digital Multimeter Fluke 112 | Fluke Deutschland GmbH / Glottertal | 81650455 | cal | cal: 2022-May-18 | cal: 24M | cal: 2024-May-18 |
| 20442 | Semi Anechoic Chamber | ETS-Lindgren Gmbh / Taufkirchen | - | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20482 | filter matrix Filter matrix SAR 1 | CETECOM GmbH | - | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20574 | Biconilog Hybrid Antenna BTA-L | Frankonia GmbH / Heideck | 980026L | cal | cal: 2022-Jun-15 | cal: 36M | cal: 2025-Jun-15 |
| 20620 | Test Receiver ESU26 | Rohde & Schwarz Messgerätebau GmbH / Memmingen | 100362 | cal | cal: 2023-May-24 | cal: 12M | cal: 2024-May-24 |
| 20885 | Power Supply EA3632A | Agilent Technologies Deutschland GmbH | 75305850 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 25038 | Loop Antenna HFH2-Z2 | Rohde & Schwarz Messgerätebau GmbH / Memmingen | 879824/13 | cal | cal: 2022-Jul-04 | cal: 24M | cal: 2024-Jul-04 |
| | 120907 - FAC2 - Radiated Emissions | | | chk | chk: 2024-Mar-18 | chk: 12M | chk: 2025-Mar-18 |
| 20005 | AC - LISN 50 Ohm/50µH ESH2-Z5 | Rohde & Schwarz Messgerätebau GmbH / Memmingen | 861741/005 | cal | cal: 2023-May-25 | cal: 12M | cal: 2024-May-25 |
| 20133 | Horn Antenna 3115 (Meas 1) | EMCO Elektronik GmbH / Gilching | 9012-3629 | cal | cal: 2023-May-22 | cal: 36M | cal: 2026-May-22 |
| 20302 | Horn Antenna BBHA9170 (Meas 1) | Schwarzbeck Mess-Elektronik OHG / Schönau | 155 | cpu | chk: 2020-Apr-15 | chk: 12M | |
| 20303 | Horn Antenna BBHA9170 (Subst 1) | Schwarzbeck Mess-Elektronik OHG | 156 | cpu | | chk: 12M | |
| 20354 | DC - Power Supply 40A NGPE 40/40 | | 448 | cpu | | | |
| 20412 | Fully Anechoic Chamber 2 | ETS-Lindgren Gmbh / Taufkirchen | without | chk | chk: 2023-Apr-14 | chk: 12M | chk: 2024-Apr-14 |
| 20729 | FS-Z140 | Rohde & Schwarz Messgerätebau GmbH / Memmingen | 101004 | cal | cal: 2023-Jun-16 | cal: 36M | cal: 2026-Jun-16 |
| 20730 | FS-Z110 | Rohde & Schwarz Messgerätebau GmbH / Memmingen | 101468 | cal | cal: 2023-Jun-02 | cal: 36M | cal: 2026-Jun-02 |
| 20731 | FS-Z75 | Rohde & Schwarz Messgerätebau GmbH / Memmingen | 101022 | cal | cal: 2022-May-18 | cal: 36M | cal: 2025-May-18 |
| 20732 | Signal- and Spectrum Analyzer FSW67 | Rohde & Schwarz Messgerätebau GmbH / Memmingen | 104023 | cal | cal: 2023-May-25 | cal: 12M | cal: 2024-May-25 |
| 20733 | Harmonic Mixer FS-Z220 | RPG-Radiometer Physics GmbH | 101009 | cal | cal: 2021-May-27 | cal: 36M | cal: 2024-May-27 |
| 20734 | Harmonic Mixer FS-Z325 | RPG-Radiometer Physics GmbH / Meckenheim | 101005 | cal | cal: 2021-May-27 | cal: 36M | cal: 2024-May-27 |
| 20765 | Pickett-Potter Horn Antenna FH-PP 40-60 | RPG-Radiometer Physics GmbH / Meckenheim | 010001 | chk | chk: 2023-Oct-20 | chk: 12M | chk: 2024-Oct-20 |
| 20767 | Pickett-Potter Horn Antenna FH-PP 140-220 | RPG-Radiometer Physics GmbH / Meckenheim | 010011 | chk | chk: 2023-Oct-20 | chk: 12M | chk: 2024-Oct-20 |
| 20811 | Horn Antenna ASY-SGH-124-SMA | Antenna Systems Solutions S.L | 29F14182337 | cal | cal: 2021-Oct-20 | cal: 36M | cal: 2024-Oct-20 |
| 20812 | Pickett-Potter Horn Antenna FH-PP-325 | RPG-Radiometer Physics GmbH / Meckenheim | 10024 | chk | chk: 2023-Oct-20 | chk: 12M | chk: 2024-Oct-20 |
| 20813 | Pickett-Potter Horn Antenna FH-PP 075 | RPG-Radiometer Physics GmbH / Meckenheim | 10006 | chk | chk: 2023-Oct-20 | chk: 12M | chk: 2024-Oct-20 |
| 20814 | Pickett-Potter Horn Antenna FH-PP 140 | RPG-Radiometer Physics GmbH / Meckenheim | 10008 | chk | chk: 2023-Oct-20 | chk: 12M | chk: 2024-Oct-20 |
| 20815 | Pickett-Potter Horn Antenna FH-PP 110 | RPG-Radiometer Physics GmbH / Meckenheim | 10014 | chk | chk: 2023-Oct-20 | chk: 12M | chk: 2024-Oct-20 |
| 20816 | SGH Antenna SGH-26-WR10 | Anteral S.L. | 1144 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20817 | Waveguide Rectangular Horn Antenna SAR-2309-22-S2 | ERAVANT / Torrance | 13254-01 | chk | chk: 2023-Oct-20 | chk: 12M | chk: 2024-Oct-20 |
| 20836 | 1-18 GHz Amplifier | Wright Technologies, Inc., Inc. / Roseville | 0001 | chk | | chk: 36M | |
| 20877 | JS42-08001800-16-8P Verstärker | Miteq Inc. | 2079991 / 2079992 | chk | chk: 2023-Feb-27 | chk: 6M | chk: 2023-Aug-27 |
| 20907 | Waveguide WR-15 attenuator STA-30-15-M2 | SAGE Millimeter Inc. | 13256-01 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20908 | Waveguide WR 10 attenuator STA-30-10-M2 | SAGE Millimeter Inc. | 13256-01 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20909 | Waveguide Horn Antenna PE9881-24 | Pasternack Enterprises, Inc. | 37/2016 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20910 | Frequency Multiplier 936VF-10/385 | MI-Wave, Millimeter Wave Products Inc. | 142 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20911 | Frequency Multiplier 938WF-10/387 | MI-Wave, Millimeter Wave Products Inc. | 141 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 20912 | Low noise Amplifier Module 0.5-4GHz | RF-Lambda Europe GmbH / Rüsselsheim | 19041200083 | cpu | chk: 2020-Dec-01 | chk: 6M | chk: 2021-Jun-01 |
| 20913 | Phase Amplitude Stable Cable Assembly DC-40GHz | RF-Lambda Europe GmbH | AC19040001 | cnn | cal: -<br>chk: - | cal: -<br>chk: - | cal: -<br>chk: - |
| 25457 | DRG Horn Antenna SAS-574 | A.H. Systems, Inc. / Chatsworth | 383 | cal | cal: 2022-Mar-28 | cal: 36M | cal: 2025-Mar-28 |

Tools used in 'P1M1'

### 4.9.1 Legend

| Note / remarks | Interval of calibration & Verification |
|---|---|
| 12M | 12 months |
| 24M | 24 months |
| 36M | 36 months |
| 10Y | 10 Years |

| Abbreviation Check Type | Description |
|---|---|
| cnn | Calibration and verification not necessary |
| cal | Calibration |
| calchk | Calibration plus intermediate Verification |
| chk | Verification |
| cpu | Verification before usage |

# 5 Results from external laboratory

| | |
|---|---|
| None | - |

# 6 Opinions and interpretations

| | |
|---|---|
| None | - |

# 7 List of abbreviations

| | |
|---|---|
| None | - |

# 8 Measurement Uncertainty valid for conducted/radiated measurements

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor **k**, such that a confidence level of approximately 95% is achieved. For uncertainty determination, each component used in the concrete measurement set-up was taken in account and it contribution to the overall uncertainty according its statistical distribution calculated.

| Issue No. | Measurement type | Reference | Frequency range of measurement | | Calculated Uncertainty based on confidence level of 95.54% | Remarks |
|---|---|---|---|---|---|---|
| | | | Start [MHz] | Stop [MHz] | | |
| 1 | Magnetic Field Strength | EN ,FCC, JP, IC | 0.009 | 30 | 4.86 | Magnetic loop antenna, Pre-Amp on |
| 2 | RF-Output Power (EIRP) Unwanted emissions (EIRP) [dB] | EN, FCC, JP, IC | 30 | 100 | 4.57 | without Pre-Amp |
| | | | 30 | 100 | 4.91 | with Pre-Amp |
| | | | 100 | 1000 | 4.02 | without Pre-Amp |
| | | | 100 | 1000 | 4.26 | with Pre-Amp |
| | | | 1000 | 18000 | 4.36 | without Pre-Amp |
| | | | 1000 | 18000 | 5.23 | with Pre-Amp |
| | | | 18000 | 33000 | 4.92 | Schwarzbeck BBHA9170 (#20302) Antenna set-up non-waveguide antenna) |
| | | | 33000 | 50000 | 4.17 | Set-up for Q-Band (WR-22), non-wave guide antenna |
| | | | 40000 | 60000 | 4.69 | Set-up U-Band (WR-19), non-waveguide antenna |
| | | | 50000 | 75000 | 4.06 | External Mixer set-up V-Band (WR-15) |
| | | | 75000 | 110000 | 4.17 | External Mixer set-up W-Band (WR-6) |
| | | | 90000 | 140000 | 5.49 | External Mixer set-up F-Band (WR-8) |
| | | | 140000 | 225000 | 6.22 | External Mixer set-up G-Band (WR-5) |
| | | | 225000 | 325000 | 7.04 | External Mixer set-up (WR-3) |
| | | | 325000 | 500000 | 8.84 | External Mixer set-up (WR-2.2) |
| 3 | Radiated Blocking [dB] | EN | 1000 | 18000 | 2.85 | Typical set-up with microwave generator and antenna, value for 7 GHz calculated |
| | | | 18000 | 33000 | 4.66 | Typical set-up with microwave generator and antenna |
| | | | 33000 | 50000 | 3.48 | WR-22 set-up |
| | | | 50000 | 75000 | 3.73 | WR-15 set-up |
| | | | 75000 | 110000 | 4.26 | WR-6 set-up |
| 4 | Frequency Error / UWB+FMCW [kHz] | EN, FCC, JP, ISED | 40000 | 77000 | 276.19 | calculated for 77 GHz (FMCW) carrier |
| | | | 6000 | 7000 | 33.92 | calculated for 6.5 GHz UWB Ch.5 |
| | Frequency Error / NFC [Hz] | EN, FCC, JP, ISED | 11.00 | 14.00 | 20.76 | calculated for 13.56 MHz NFC carrier |
| 5 | TS 8997 Conducted Parameters | FCC15/18 / ISED | 30 | 6000 | 1.11 | 1. Power measurement with Fast-sampling-detector |
| | | | 30 | 6000 | 1.20 | 2. Power measurement with Spectrum-Analyzer |
| | | | 30 | 6000 | 1.20 | 3. Power Spectrum-Density measurement |
| | | | 30 | 7500 | 1.20 | 4. Conducted Spurious emissions |
| | | | 0.009 | 30 | 2.56 | 5. Conducted Spurious emissions |
| | | | 2.4 | 2.48 | 1.95 ppm | 6a. Bandwidth / 2-Marker Method for 2.4 GHz ISM |
| | | | 5.18 | 5.825 | 7.180 ppm | 6b. Bandwidth / 2-Marker Method for 5 GHz WLAN |
| | | | 5.18 | 5.825 | 1.099 ppm | 7. Frequency (Marker method) for 5 GHz WLAN |
| | | | 30 | 6000 | 0.11561 µs | 8. Medium-Utilization factor / Timing |
| | | | 30 | 6000 | 1.85 | 9a. Blocking-Level of companion device |
| | | | 30 | 6000 | 1.62 | 9b. Blocking Generator level |
| 6 | Conducted Emissions | EN, FCC | 0.009 | 30 | 3.57 | general EMI-measurements on AC/DC ports |

# 9 Versions of test reports (change history)

| Version | Applied changes | Date of release |
|---|---|---|
| -- | ➢ Initial release | 2025-Feb-20 |
| C1 | ➢ Annex-5 has been added on page 3,<br>➢ Partial (Infront of test report) has been removed from front page,<br>➢ Summary of test result for modulation characteristics on page 5 has been updated,<br>➢ Chapter 2.8 (untested variant) has been updated. | 2025-Jun-04 |
| C2 | ➢ Annex-6 has been added on page 3 | 2025-Jun-05 |
| C3 | ➢ Annex-5 is mentioned as document on page 13 | 2025-Jun-12 |
| -- | -- | -- |

## End Of Test Report